METHOD, APPARATUS, COMPUTER-READABLE MEDIA AND USER INTERFACE FOR ANNUNCIATING PROBLEMS IN A SYSTEM

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates to the management of systems and more particularly to methods, apparatus, computer-readable media and a user interface for annunciating problems in a system.

2. Description of Related Art

Tools exist for the management of system problems, such as those encountered in telecommunications networks. These system management tools typically operate on a PC or UNIX workstation and enable the maintenance, surveillance and administration of multiple telecommunications network elements making up the system. Such tools provide for management of the network, that is, monitoring alarms, monitoring performance, managing connections and testing for faults.

An objective of existing system management tools is to provide a centralized view of a system so as to enable the operator to identify system problems from multiple events or conditions, such as alarms and performance degradations. For example, an initial root cause, such as an alarm, can often cause a cascade or flood of subsequent events through the system. Many events, such as alarms and performance degradations, can therefore be symptomatic of a single system problem. When there are many such events, it becomes difficult to determine which ones are correlated to a root cause system problem.

Some existing system management tools provide a GUI (graphical user interface) to assist the operator. One example is HP Open View Network Node Manager, provided by Hewlett-Packard Corporation of California, U.S.A. Such tools commonly represent a number of telecommunications network elements on a display in a topological configuration, but the display may be cluttered with iconic representations of a state for each network element. While such a display helps the operator to locate individual alarms or performance degradations in a system, it may not help the operator identify the relationships among these events and system problems, or root causes of problems.

Root-cause analysis tools have been developed for telecommunications networks and may correlate alarm events into problem sets, each set consisting of a direct detected alarm event and a correlated set of symptomatic alarm events. This automated correlation greatly reduces the amount of time the operator would have to spend in manually filtering the alarm events. Furthermore, such tools direct the operator's attention from dealing with individual events to dealing with overall problem sets. Some tools are capable of providing a brief probable cause description of the problem set and of providing a reference that can be used to help correct the problem set.

Most root-cause analysis tools are limited to use with certain types of alarm events. From a flood of different types of alarm events, they select one type of alarm and perform an exhaustive search for alarms of that type only. This allows many different types of alarm events to be treated as symptomatic of a single system problem.

Other tools allow an operator to examine service violations associated with an event. Often, an operator is responsible for maintaining intended service levels across the telecommunications network. These intended service levels could relate to agreements with customers, for example. There may also be

penalties or costs associated with failure of the system to comply with the intended service levels described by clauses in a service level agreement (SLA), for example. Compliance of a particular telecommunications network element with a plurality of intended service levels may be crucial. Tools which provide this type of information allow the operator to examine intended service levels and observe service violations associated with a particular event or a particular telecommunications network element.

Generally existing system management tools help the operator to diagnose system problems and synthesize a great deal of information through a centralized view of the system, such as the telecommunications network described above. However, they leave a large amount of information to be synthesized by the operator, unaided. The operator may have to examine details of performance degradations to determine the system problems to which they relate. The operator may have to separately examine details of service violations to determine the system problems to which they relate, and to determine the relative importance of the system problems. The operator may use these determinations to prioritize the system problems and to schedule and plan maintenance and repair of the system. However, little is done by existing tools to summarize such details into problem priority information that could assist the operator in quickly identifying and prioritizing system problems. Consequently, there is a need for system management tools which provide a better description of system problems to permit an operator to better identify and prioritize system problems.

SUMMARY OF THE INVENTION

The present invention addresses the above need by providing, in accordance with one aspect of the invention, a method and apparatus for annunciating problems in a system. The method involves producing signals for concurrently indicating a plurality of system problems and problem priority information associated with the system problems, in response to data

representative of system conditions. This conveys improved information regarding problems in a system.

For example, a particular system problem may be related to performance degradation in the system. Characterizing the performance degradation information associated with a particular problem can be useful as priority information. As another example, a particular system problem may be related to service violation information detailing failure of the system to comply with intended service levels, allowing prioritization of problem correction according to business metrics. Characterizing the service violation information associated with a particular problem can also be useful as problem priority information. As a further example, a particular system problem may have a relative importance in view of monetary penalties or lost income or customer goodwill, while the problem remains uncorrected, for example. Characterizing the relative importance of the system problems can be useful as problem priority information.

In order to provide the association between the problem priority information and the system problems, a correlation between data representative of system conditions and system problems may be made. Performance degradation information and service violation information, and/or alarm information may be correlated with a particular system problem, for example. The root cause of the system problem may also be identified.

Problem priority information may help the operator to understand system problems by assessing the different perspectives provided by different priority information. Optionally, the operator can also view detailed information related to a particular system problem, such as performance degradation information, or service violation information, and/or alarm information, for example, in a system problem hierarchy, revealing a hierarchy of information available to help the operator to prioritize and schedule repair or maintenance activities.

Preferably, the method involves quantification of performance degradation information and service violation information represented in the data. Correlating the performance degradation information and the service violation information identifies the problem priority information associated with each system problem. This correlated information may also be used to quantify a relative importance of the system problems to provide further problem priority information. The problem priority information for each system problem may be depicted concurrently with the system problems. Details of performance degradation information and service violation information may also be available with priority information.

The method may also involve providing signals to display a system problem hierarchy, listing the system problems, and listing the performance degradation information, alarm information and/or service violation information associated with a selected system problem. The method may further involve the display details of selected data such as alarm data, performance data and/or service violation information.

In accordance with another aspect of the invention, there is provided a method of annunciating problems in a system. The method involves displaying a plurality of system problems and problem priority information associated with the system problems in response to data representative of system conditions.

In accordance with another aspect of the invention, there is provided a computer readable medium for providing instructions for directing a processor circuit to produce signals for concurrently indicating a plurality of system problems and problem priority information associated with the system problems, in response to data representative of system conditions.

In accordance with another aspect of the invention, there is provided a signal embodied in a carrier wave, the signal comprising a code segment for directing a processor circuit to produce signals for concurrently indicating a plurality of system problems and problem priority information associated with the system problems, in response to data representative of system conditions.

In accordance with another aspect of the invention, there is provided an apparatus for annunciating problems in a system, comprising a device for receiving data representative of system conditions and a device for producing signals for concurrently indicating a plurality of system problems and problem priority information associated with the system problems, in response to the data.

Various aspects of the invention may be particularly applicable for use in annunciating problems in a telecommunications network in which the system problems and priority information are concurrently depicted, and optionally, details of alarm data, performance degradation data and service violation data correlated to the system problem may also be depicted. The network may provide performance degradation information and service violation information relating to the telecommunications network in data units. An alarm data unit may provide information regarding an alarm raised by a physical network element. A physical network element may be a network hub, a switch, or a repeater, for example. A performance degradation data unit may provide information regarding failure to meet a particular performance level based on a particular performance metric. The performance metric may be a call rate threshold or a frame loss rate, for example. A service violation data unit may provide information regarding a failure to comply with an established service level based on a particular service metric. The service metric could be mean time between failures or latency, for example. Alarm data units, performance degradation data units and service violation data units may be correlated to the system problems. One of these alarm data units and/or performance degradation data units may be designated as being the root cause of a

system problem. The priority information in this embodiment may include counts of the alarm data units, performance degradation data units and service violation data units correlated to the system problem. The priority information in this embodiment may further include a relative importance value calculated from penalties associated with respective service violations.

Alternatively, embodiments of the invention may be applied to systems other than telecommunications networks, such as service organizations, for example.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings which illustrate embodiments of the invention,

Figure **1** is a schematic representation of an apparatus according to a first embodiment of the invention;

Figures 2A and 2B are ~~Figure 2~~ is an exemplary screen shot produced by the apparatus shown in Figure **1**, showing service violation details;

Figures 3A and 3B are ~~Figure 3~~ is a second exemplary screen shot produced by the apparatus shown in Figure **1**, showing alarm details;

Figures 4A and 4B are ~~Figure 4~~ is a third exemplary screen shot produced by the apparatus shown in Figure **1**, showing performance degradation details;

Figure **5** is a block diagram of a signal generator of the apparatus shown in Figure **1**;

Figure **6** is a tabular representation of an alarm data unit received by the apparatus shown in Figure **1**;

Figure **7** is a tabular representation of a performance degradation data unit received by the apparatus shown in Figure **1**;

Figure **8** is an exemplary service violation data unit received by the apparatus shown in Figure **1**;

Figure **9** is a problem record produced by the apparatus shown in Figure **1**;

Figure **10** is a flowchart of a process executed by a processor shown in Figure **5**, for correlating uncorrelated data units with correlated data units of the type shown in Figures **6**, **7** and **8** and for updating problem records of the type shown in Figure **9**;

Figure **11** is a flowchart of a sub-process initiated in the process shown in Figure **10**, for associating and maintaining a problem record of the type shown in Figure **9** with a data unit of the type shown in Figures **6**, **7** and **8**; and

Figure **12** is a flowchart of a sub-process initiated by the process shown in Figure **10** for updating a problem record of the type shown in Figure **9**.

DETAILED DESCRIPTION

Referring to Figure **1**, an apparatus for annunciating problems in a system, according to a first embodiment to the invention is shown generally at **10**. The

apparatus includes a receiver, which in this embodiment is transceiver **12** for communicating with system monitoring equipment (not shown) to receive data representative of system conditions. The apparatus further includes a signal generator **14** for producing signals at an output shown generally at **16**, for concurrently indicating a plurality of system problems and problem priority information associated with such system problems, in response to data received at the transceiver **12**.

Generally conditions of a given system may be indicated by alarms, performance degradations and service level violations, for example. Typically, a service provider operating a system for providing a service will set particular limits on the operation of the service, to monitor its performance. At the same time, the service provider may have contracted with customers to provide particular levels of service. In addition, certain aspects of the performance of the system may be monitored for quantitative values, such as data throughput, for example, on a network. In the discussion that follows, the apparatus according to the first embodiment will be described in the context of a telecommunications network. In such a telecommunications network, there may be a plurality of network elements which may produce alarms such as to reflect the failure of a communications subsystem, for example. In the event of such an occurrence, a network manager device (not shown) may provide alarm data, indicative of the communications subsystem failure.

In addition, the network manager device may provide indications of performance degradations of network element equipment, such as an indication of an actual marginal call rate relative to a threshold marginal call rate, for example.

The operator of the network may have contracted with customers to guarantee certain levels of service and to accept penalties for failure to provide service at the contracted levels. Such commitments are normally set forth in a service level agreement on a customer-by-customer basis. Thus, a

company such as Air Canada may have a service level agreement with the network service provider, whereby the network service provider agrees to provide a mean time between failure of five days, with a penalty of **$500.00** per second, for example.

In general, data relating to alarm information, performance degradation information and service violation information is provided to the apparatus **10** by one or more components of the network. Such components may be apprised of network technology, network topology, routes and paths and may maintain a service level agreement database for each customer. Such components may variously comprise network elements, network tools, software devices or other technologies.

Based on data provided by these one or more network components, the apparatus **10** effectively produces signals for concurrently indicating a plurality of system problems and problem priority information associated with such system problems as indicated in Figures ~~**2, 3 and 4**~~ 2A, 2B, 3A, 3B, 4A and 4B. Referring back to Figure **1**, the signals produced at the output **16** of the apparatus **10**, may drive an annunciation device, which in this embodiment is a display device shown generally at **18**. The display device may be a computer monitor, for example, and the apparatus **10** itself may be encompassed within a computer **20** having a keyboard **22** for receiving user/operator input. It will be appreciated that the transceiver **12** may be located inside or outside of the computer **20** and merely serves to format the data received from the network component or components, into a format compatible with and useful for the signal generator **14**.

Referring to Figure **5**, an exemplary signal generator is shown generally at **14**. This signal generator **14** includes a processor **24**, permanent memory **26**, temporary memory **28** and an I/O unit **30**, all in communication with the processor **24**. Effectively the permanent memory stores code segments **32** for directing the processor **24** to carry out methods according to this

embodiment of the invention. In doing so, the processor may be directed to access the temporary memory **28** and to access the I/O unit **30**.

Effectively, the code segments **32** may be received at an input **34** of the I/O unit **30** and subsequently stored in the permanent memory **26**. The code segments may be received in a carrier wave, for example, which is demodulated to extract the code segment and apply it as a data signal to the input **34**. Alternatively, the processor may have a disc drive or a tape drive (not shown) for enabling the processor to receive the code segment **32** from a computer readable medium.

The I/O unit **30** has an input **36** for receiving alarm data, performance degradation data and service level violation data, from one or more network components capable of providing such data. In response, the code segment **32** directs the processor to store the data in the temporary memory **28**. Then, the code segment **32** directs the processor to examine and correlate the data and to produce signals at an output **38** of the I/O unit **30**, which in this embodiment are received by a display signal generator **40** which has an output **42** for producing a composite video signal for driving the display device **18** shown in Figure **1**. Particular selections of what information is to be included within the signals produced at the output **38**, and ultimately the signals included within the composite video signal produced at the output **42**, are determined by the correlations determined by the processor **24** and user input received at a further input **44** of the I/O unit **30**.

Referring to Figure **6**, exemplary alarm data according to the first embodiment of the invention may be provided to the transceiver **12** of Figure **1** from network system components, in the form of a packet of data or data unit shown generally at **50**. In this embodiment the alarm data unit **50** includes a data unit type field **52**, a network element ID field **54**, a network element name field **56**, an alarm identification field **58**, a time field **61** and a plurality of other

fields shown generally at **60**, which generally define the alarm. The alarm data further includes a root cause flag field **62** and a problem ID field **64**.

In this embodiment, the alarm data unit **50** is prepared by an alarm correlator device and method described in United States Patent application No. **09/298,832**, which is owned by the assignee of the present application, and which is incorporated herein by reference. This apparatus and method provide for automatic correlation of problem identifications with network element identifications and alarm identifications. Thus, before the alarm data unit is received by the transceiver **12** the contents of the problem ID field **64** of the alarm data unit **50** are determined by the above-mentioned alarm correlator devices and method and this serves to establish at least an initial correlation between problem identification and alarm identification and network element identifications for use by the apparatus **10** according to this embodiment. In addition, the alarm correlator described above identifies an alarm indicative of the root cause of the problem identified in the problem ID field **64** and provides a true or false value in the root cause flag field **62** indicating whether or not the alarm represented by the alarm data unit is identified as the root cause of the problem identified in the problem ID field **64**.

Referring to Figure **7**, exemplary performance degradation data is shown in the form of a performance degradation data unit shown generally at **70**. This type of performance degradation data unit **70** is provided to the transceiver **12** by network equipment capable of monitoring at least one network performance metric. In this embodiment, the performance degradation data unit includes a data unit type field **72**, a network element name field **74**, a network element ID field **76**, a unit field **78**, a metric field **80** indicative of the metric being monitored, an actual value field **82** for holding a value representing an actual value of the metric identified by metric field **80**, a threshold field **84** for identifying a threshold value of the metric, a network service field **86**, a time field **88** for identifying when the measurement of the metric was taken, and a blank problem ID field **90**. The problem ID field is left

blank for completion by the apparatus **10** according to the present embodiment of the invention as it carries out the function of correlating as will be described below.

Referring to Figure **8**, service violation data is shown in the form of a service violation data unit shown generally at **100** and is produced by network equipment capable of monitoring service level agreement violations and providing service violation data units of the type described. The service violation data unit **100** includes a data unit type field **102**, a customer field **104**, a customer service field **106**, a level field **108** for identifying the quality of the service, a metric field **110** for identifying a network metric which is the subject of a clause in a service level agreement, a delivered field **112** for identifying the performance achieved under the metric, an agreed field **114** for identifying the agreed performance to be provided under the metric according to the service level agreement, a penalty/impact field **116** for identifying the cost associated with failure to meet the agreed performance under the metric, a contract ID field **118** for providing an index to a contract in which the agreement as to performance under the metric is indicated, a time field **119** indicating the time of the service violation, and a plurality of network ID fields shown generally at **120** for identifying network elements which affect the ability to deliver the performance agreed under the metric, and finally a problem ID field **122** which is left blank. Again, the problem ID field **122** is completed by the apparatus **10** according to the present embodiment of the invention in performing its correlation functions.

Effectively, the alarm data unit **50** shown in Figure **6**, the performance degradation data unit **70** shown in Figure **7**, and the service violation data unit **100** shown in Figure **8**, are presented to the transceiver of the apparatus **10** shown in Figure **1**, by equipment which in this embodiment does not form part of the apparatus **10** shown in Figure **1**. Rather these data units are provided by one or more network components having the capability of monitoring network performance, to produce such data units.

Effectively, in response to receiving data such as in data units of the type shown in Figures **6** to **8**, the apparatus shown in Figure **1** produces problem records of the type shown at **130** in Figure **9**. Such a problem record includes a problem ID field **132**, a problem description field **134**, a violation count field **136**, an alarm count field **138**, a degradation count field **140**, a cost field **142**, a time field **144**, a cause and correction field **146**, and a document reference field **148**. The contents of at least some of the above fields are represented in the signals ultimately appearing at the output **42** of the display signal generator shown in Figure **5**, to produce a problem record, an exemplary one of which is shown at **150** in Figures 2A, 3A and 4A where the contents of the fields shown in the problem record **130** shown in Figure **9** are shown in a line, in association with each other. Furthermore, the contents of the fields shown in Figure **9** represent information related to a system problem, and in this embodiment, the signals produced by the apparatus shown in Figure **1**, cause a plurality of system problems to be listed in a problem list, along with similar information relating to the system problem, arranged in a manner which provides for easy comparison of problem information by an operator viewing a display on which the problem list is presented. This information includes problem priority information shown at **152**, **154**, **156** and **158** in Figure 2A, corresponding to fields **136**, **138**, **140** and **142** of problem record **130** shown in Figure **9**.

In order to produce a problem record **130**, the code segment **32** shown in Figure **5** directs the processor **24** to execute a process which is exemplified by the process shown at **160** in Figure **10**. This process begins by directing the processor **24** to search the temporary memory **28** for uncorrelated data units. This is exemplified at block **162** in Figure **10**. In order to determine whether or not a data unit is correlated or uncorrelated, the appropriate problem ID field **64** in Figure **6**, **90** in Figure **7** and **122** in Figure **8**, is read to determine whether or not the contents bear a valid problem identification code. Initially, therefore, if service violation data units **100** are received or

performance degradation data units **70** are received without first having received at least one alarm data unit **50**, such service violation data units **100** and performance degradation data units **70** will not yet be correlated.

When an alarm data unit **50**, shown in Figure **6**, is received, an initial correlation is provided between a problem ID as indicated in the problem ID field **64** thereof and a network element ID as indicated in the network element ID field **54** thereof. Then, any existing or subsequently received service violation data units **100** and/or performance degradation data units **70** may be correlated with an already received alarm data unit **50**. Thus, if at block **164** there are new received data units, block **164** directs the processor to proceed to block **166**. When a new data unit is received, block **166** directs the processor to process the new data unit according to the process shown at **166** in Figure **11**.

The process shown in Figure **11** begins with block **168** which directs the processor to determine whether or not the received data unit has a problem ID in the problem ID field **64**, **90** or **122** in Figures **6**, **7** and **8**, respectively. If so, then block **170** directs the processor **24** to determine whether or not there is a problem record **130** having a problem ID field **132** with the same problem ID. If not, then block **172** directs the processor **24** to create a problem data record for this problem ID. In this regard, a blank problem record is produced. If at block **170** there is an existing problem record for the identified problem, or if a new problem record has been created, block **174** directs the processor **24** to update the problem record fields for the identified problem. To do this, the processor **24** is directed to the process shown at **176** in Figure **12**.

Referring to Figure **12**, block **178** directs the processor **24** to increment the corresponding violation count field **136**, alarm count field **138** or degradation count field **140**, depending on the data unit type of the new data unit. Block **180** then directs the processor **24** to compare the problem record time field **144** to determine whether or not there is a prior/older time in the new data unit

and, if so, then block **182** directs the processor **24** to update the problem time field **144** shown in Figure **9** with the time in the time field **61**, **88** or **119** of the new associated data unit **50**, **70** or **100**. Then, block **184** directs the processor **24** to determine whether or not there is a penalty associated with the problem as indicated if the new data unit is a service violation data unit **100**, and if so, block **186** directs the processor **24** to add the cost indicated in the penalty impact field **116** of the service violation data unit **100** shown in Figure **8**, to the cost field **142** of the associated problem record **130** shown in Figure **9**.

It will be appreciated by one of ordinary skill in the art that there are alternative ways to calculate a problem cost for the problem cost field **142**. Such alternatives could involve identifying particularly important customers, related to the data units, identifying particularly important network elements, or accessing additional data relating to problem cost, for example.

After completing block **174**, the processor **24** is then directed back to block **188** of Figure **11**, which causes it to read the contents of the root cause flag field **62** if the new data unit is an alarm data unit **50** shown in Figure **6**, to determine whether or not the contents of the root cause flag field **62** indicates that the alarm data unit **50** shown in Figure **6** is associated with a root cause of the problem. If so, then block **190** directs the processor **24** to look in a lookup table (not shown) to locate and produce signals to display corrective information and an associated document reference, for the indicated root cause.

If the root cause flag **62** is found not to be set, such that the alarm data unit is not associated with the root cause of the problem, or if corrective action and a document reference for an indicated root cause have been provided, the process shown in Figure **11** is completed and the processor **24** is returned to block **162** in Figure **10**. Thus, the processes carried out by blocks **162** through **166** and the processes shown in Figures **11** and **12**, serve to create

or update problem records in response to correlated data units received by the apparatus **10**.

If at block **162**, an uncorrelated data unit is found in the temporary memory **28**, block **200** directs the processor **24** to get the uncorrelated data unit from memory. Then, block **202** directs the processor **24** to determine whether or not any correlated data unit (that is one having a completed problem ID field **64**, **90** or **122** in Figures **6**, **7** or **8**, respectively), has not yet been compared to the data unit obtained at block **200**. If all correlated data units have been compared to the presently obtained data unit, then the processor **24** is directed back to block **160**. If any correlated data unit has not yet been compared to the present data unit, then block **204** directs the processor **24** to determine whether or not the present data unit is associated with the same network element of another data unit with which a problem ID has been associated. If not, then the processor **24** is directed back to block **202** to compare the present data unit with any other correlated data unit with which it has not yet been compared. If at block **204**, the present data unit and the data unit to which it is being compared share a network element, then block **206** directs the processor **24** to use a lookup table to determine whether alarms and metrics indicate a common problem.

Each data unit has either a type of metric or type of alarm indicated at **58** in Figure **6**, at **80** in Figure **7**, or at **110** in Figure **8**. The lookup table (not shown) indicates whether different types of alarm and types of metric are symptomatic of a common problem. The lookup table contains one such indication for each possible pairwise combination of alarm and metric types. Thus, by looking up the type of alarm or metric **58**, **80**, or **110**, from both the present data unit and the existing correlated data unit to which it is being compared, the lookup table indicates whether these data units relate to a common problem. If they do not relate to a common problem, then the processor **24** is directed back to block **202**. If they relate to a common problem, the processor **24** is directed to block **208** which causes it to correlate the present data unit with the existing correlated data unit. This is done by

storing the contents of the problem ID field of the existing correlated data unit in the problem ID field of the present uncorrelated data unit (thereby making it correlated). Then, at block 209, the process shown at **176** in Figure **12** is run to update the problem record **130** shown in Figure **9**. In the above manner, problem records are continually updated as new data units and previously uncorrelated units are correlated with existing correlated data units.

It will be appreciated by one of ordinary skill in the art upon review of this specification that there are alternative ways to correlate data units. The particular data fields to be compared and the manner of comparison will depend on the application domain and desired result.

Referring to Figures 2A, 2B, 3A, 3B, 4A and 4B, ~~2, 3 and 4~~, the processor **24** shown in Figure **5**, is programmed to receive user input such as may be provided by the keyboard **22** shown in Figure **1**, to permit a user to select problems from among the problem list, for which more detail is desired. More detail is provided in the form of a detail list, which in this embodiment includes details of service violations as shown at **210** in Figure 2B, alarms such as shown at **212** in Figure 3B, and performance degradations such as shown at **214** in Figure 4B.

Referring to Figure 2B in this embodiment, service violations are displayed on respective rows and the data seen on each respective row is obtained from corresponding fields of the associated service violation data unit **100** shown in Figure **8**. The appropriate service violation data unit is determined by the contents of the problem ID field **122**, which is specified by the problem selected by the user from the problem list. Thus, using the problem ID associated with the user selected problem from the problem list, service violation data associated with the identified problem may be listed and displayed.

Similarly, alarm information for each alarm is shown on a respective line or row in the display shown at **212** in Figure 3B. Similarly, performance degradation information is shown on respective rows of the display **214** shown in Figure 4B.

Referring to Figures ~~2, 3 and 4,~~ 2A, 2B, 3A, 3B, 4A and 4B it will be appreciated that once a user selects a problem from the problem list, the user may then select one of three tabs **216**, **218** and **220**, to cause details of service violations, alarms, and performance degradations respectively to be displayed.

In addition, the display produced by the apparatus may include a further information area shown generally at **222** for providing further information pertinent to resolution of the problem. Such additional information may be provided by accessing one or more lookup tables using the contents of any of the fields in any row of the displayed detail list. Thus, for example, notes about the contracted level of service for a selected customer, and customer contact information, may be provided in the further information area **222**. In addition, a view contract button **224** may be provided on the display to provide an immediate link to the actual service contract with the indicated customer, which in this example is "Joe's Garage". Similarly, as shown in Figure ~~3~~5, information about the location of a selected alarm may be provided in the further information area **222**.

Similarly, referring to Figure ~~4~~B trend information, for example, may be shown in the further information area, to indicate trends of a particular metric on a particular piece of equipment such as "**474** Bank RTR" may be displayed. Rather than providing such trend information in a lookup table, the processor **24** may be programmed to access a server for such information in response to user selection of a particular row in area **214**. In the above manner, a system problem hierarchy is shown whereby a problem list listing problems with the system providing the service to customers, shown at **151** in Figures ~~2, 3 and 4~~, 2A, 3A and 4A is provided at the top of the display and sub-components of a selected problem are selectively displayed in a middle portion of the display, as shown at **210**, **212** and **214**, and further information relating to user selected details listed in the middle portion of the display are shown in a lower portion of the display, as shown at **222** in Figures ~~2, 3 and 4,~~ 2B, 3B and 4B thus completing and facilitating the display of problem hierarchy.

Thus, the apparatus and methods described herein provide for identifying and prioritizing problems in a system in order to determine appropriate strategies or scheduling for maintenance or repair. Systems may exhibit many symptoms and effects related to problems that can be much more easily assessed with the help of the apparatus and methods described herein to organize and present appropriate information in a comprehensive manner.

While specific embodiments of the invention have been described and illustrated, such embodiments should be considered illustrative of the invention only and not as limiting the invention as construed in accordance with the accompanying claims.